SD11
A571
no. 347

United States
Department of
Agriculture

Forest Service

North Central
Forest Experiment
Station

Research Note NC-347
1989

Rooting Depths of Red Maple (*Acer Rubrum* L.) on Various Sites in the Lake States

Carl L. Haag, James E. Johnson, and Gayne G. Erdmann

ABSTRACT.—Rooting depth and habit of red maple were observed on 60 sites in northern Wisconsin and Michigan as part of a regional soil-site study. Vertical woody root extension on dry, outwash sites averaged 174 cm, which was significantly greater than the extension on sites with fragipans (139 cm) and on wet sites (112 cm). Site index was higher on wet sites and non-woody root fans proliferated in the subirrigated zone there. Non-woody root fans were observed at depths approaching 3 m on dry, sandy sites.

KEY WORDS: Rooting habit, root system morphology, rooting patterns, non-woody root fans.

Red maple occurs on a variety of sites (Curtis 1959) and is increasing in abundance in the Lake States. Found on more than 400,000 ha in the region, it is also now recognized as an important source of pulpwood, fuelwood, and sawtimber (Crow and Erdmann 1983). There is evidence that red maple occupies some of the growing space vacated by American elm (*Ulmus americana* L.) killed by Dutch elm disease (Barnes 1975). Red maple has a significant competitive advantage in the northern forest because it is moderately shade tolerant, grows faster than most of its associates, produces regular and abundant seed crops, has minimal seedbed requirements, and sprouts prolifically. Many scientists have investigated the rooting system of red maple (*Acer rubrum* L.) (Hosner and Boyce 1962; Lyford and Wilson 1964; Medve 1970a, 1970b; Wilson 1971); however, rooting habit on a wide range of sites has not been clearly understood. The rooting habits of red maple on wet sites have been described by Lyford and Wilson (1964); however, observations on droughty and subirrigated sites have been limited. We conducted a study to observe the depths and morphological patterns of red maple roots on a variety of sites in northern Wisconsin and Michigan.

Carl L. Haag is a Senior Project Forester with the Scott Paper Co., Fairfield, Maine; **James E. Johnson** is an Associate Professor of Forestry with the Department of Forestry, Virginia Tech, Blacksburg, Virginia; and **Gayne G. Erdmann** is a Research Forester (retired) with the North Central Forest Experiment Station, Rhinelander, Wisconsin.

Methods

As part of a regional red maple soil-site study in northern Wisconsin and Michigan, we identified 60 red maple stands for study (fig. 1). The stands were relatively pure, even-aged, seedling origin stands on a wide variety of sites. The stands averaged 65 years of age, with 30.5 m^2/ha of basal area and an average site index of 17.3 m.

A 2 m x 3 m soil pit was excavated to a depth of 2 m in a representative spot in each stand. We located soil pits in areas of uniform microrelief without evidence of past disturbance by tree tipping. Soil bucket auger samples were collected from the bottom of each pit to a depth of 4 m from the surface. The soil profiles were completely described by horizons, and each soil was classified according to Soil Conservation Service taxonomy (Soil Survey Staff 1975). We identified red maple

LIBRARY COPY
ROCKY MTN. FOREST & RANGE
EXPERIMENT STATION

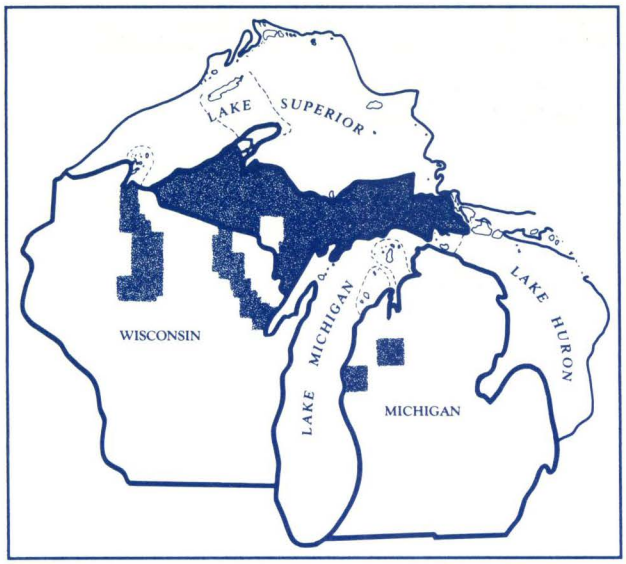

Figure 1.—*Location of study area in northern Wisconsin and Michigan.*

roots and measured rooting depth in each soil pit. Although all roots in the pits were not excavated back to the parent trees, red maple root characteristics such as bark and wood were used to identify roots in those stands where there were other tree species present. We also recorded rooting habit by horizon.

Results and Discussion

Several important differences were discovered regarding red maple rooting depth and morphology in soils with different moisture regimes. Lyford and Wilson (1964) reported less frequent branching and greater extension of woody roots on very dry outwash sites in Massachusetts than would be found on mesic or wet sites. We found extensive vertical rooting on dry, glacial outwash sites in northern Wisconsin and Michigan, with elongation occasionally reaching depths of 3 m (fig. 2). The means, ranges, and standard deviations of the rooting depths for three different soil groupings are listed in table 1. The Haplorthods consisted predominantly of dry, sandy, outwash sites with an average rooting depth of 174 cm, significantly deeper than the Fragiorthods (139 cm) or Haplaquods (112 cm). Rooting depths on sites in the last two groups were restricted by fragipan and a water table, respectively. The Haplaquods were generally wet soils, while the Fragiorthods were somewhat mesic, with water frequently perched in the soil profile above the fragipan.

In addition to the differences in rooting depth, we also found differences in root system morphology. Although non-woody root fans were most prolific in the forest floor and surface mineral soil horizon, they were also observed in the soil zone below the seasonal high water table and above the seasonal low point (fig. 2). These subirrigated sites, indicated as Haplaquods in table 1, had significantly higher site indices than the drier, outwash sites typified by the Haplorthods. These root fans are the tree's primary water and nutrient absorbers (Lyford and Wilson 1964), and the proliferation of these roots in the subirrigated zone may explain the higher site indices on these sites.

Higher site indices were also noted on soils that had an accumulation of fine-textured soil material in the solum (fig. 2). In the field, these fine-textured zones were infiltrated with non-woody root fans, presumably in response to the increased water-holding capacity and cation exchange rate associated with the clay fraction.

Red maple is an opportunistic species both above and below ground. Red maple trees develop greater vertical rooting on dry sites and prolific feeding root fans in localized wet horizons and clay zones. These root fans capitalize on additional available water and nutrients, resulting in increased tree height growth and higher site indices.

Table 1.—*Mean red maple rooting depth for three soil groupings*

Moisture regime	Soil grouping	No. sites	Rooting depth (cm) Mean	Range	SD	Site index[2] (m) Mean	SD
Dry	Haplorthods	30	174a[1]	80-230	51	16.2a[1]	2.4
Mesic	Fragiorthods	15	139c	40-230	59	18.5b	1.7
Wet	Haplaquods	15	112b	110-230	28	18.0b	1.8

[1]Means within a column followed by different letters are significantly different at the 0.05 level.

[2]Site index is expressed as the height of dominant and codominant trees in the stand at age 50.

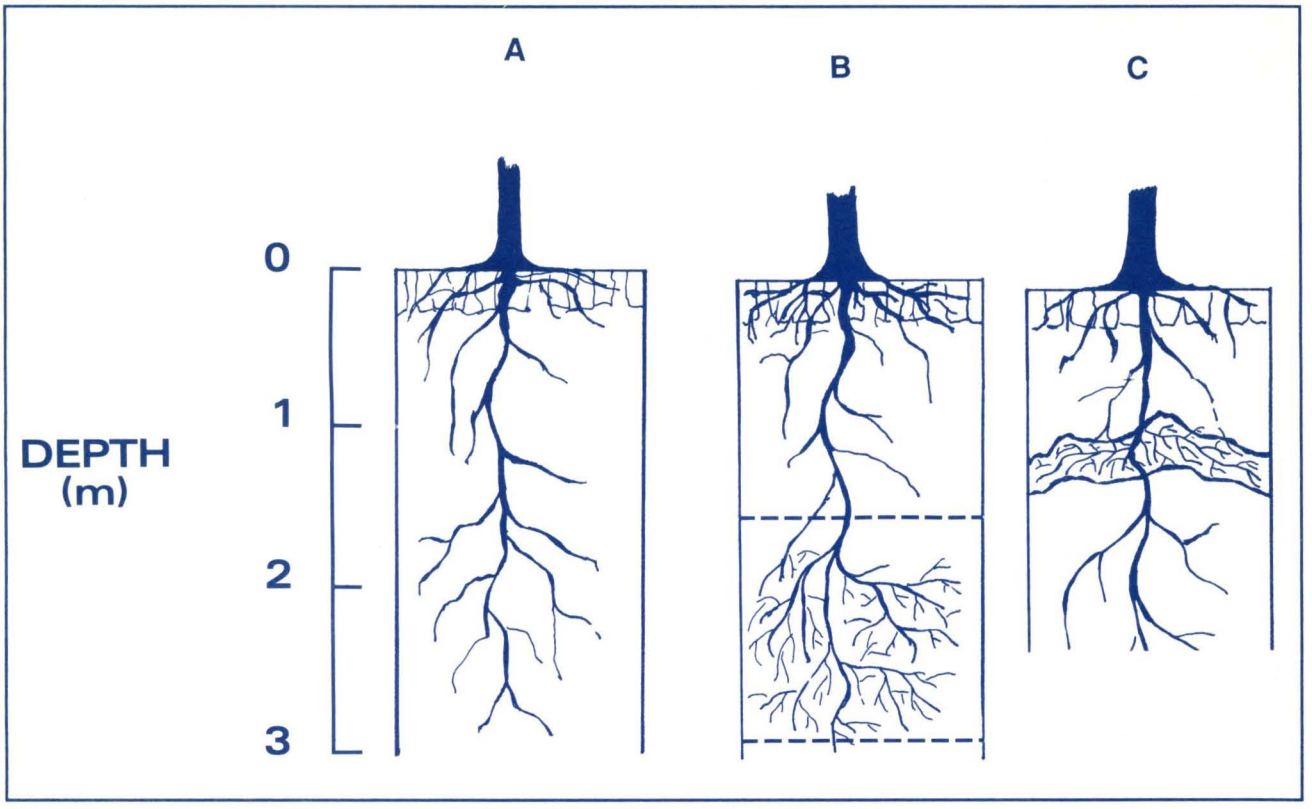

Figure 2.--*Rooting patterns of red maple on (A) sandy, outwash sites, (B) sites with a fluctuating water table (dashed lines represent zone of seasonal wetness), and (C) sites with a clay-enriched horizon (solid line at 1.0 to 1.5 m indicate clay-enriched horizon).*

Literature Cited

Barnes, B.V. 1975. **Succession in deciduous swamp communities of southwestern Michigan formerly dominated by American elm**. Canadian Journal of Botany. 54: 19-24.

Crow, T.R.; Erdmann, G.G. 1983. **Weight and volume equations and tables for red maple in the Lake States**. Res. Pap. NC-242. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 14 p.

Curtis, J.T. 1959. **The vegetation of Wisconsin**. Madison, WI: University of Wisconsin Press. 675 p.

Hosner, J.F.; Boyce, S.G. 1962. **Tolerance to water saturated soil of various bottomland hardwoods**. Forest Science. 8: 180-186.

Lyford, W.H.; Wilson, B.F. 1964. **Development of the root system of *Acer rubrum* L.** Harvard For. Pap. 10. Cambridge, MA: Harvard University. 17 p.

Medve, R.J. 1970a. **The relationship of beaded rootlets and mycorrhizae of red maple (*Acer rubrum* L.)**. American Midland Naturalist. 83: 631-634.

Medve, R.J. 1970b. **Influence of genotype and soil on root fan structures of *Acer rubrum* L.** Canadian Journal of Botany. 48: 147-152.

Soil Survey Staff. 1975. **Soil taxonomy**. Agric. Handb. 436. Washington, DC: U.S. Department of Agriculture, Soil Conservation Service. 754 p.

Wilson, B.F. 1971. **Vertical orientation of red maple (*Acer rubrum* L.) roots**. Canadian Journal of Forest Research. 1: 147-150.

Acknowledgements

The authors would like to thank T. Crow for his assistance, and M. Birckhead for drafting the figures in this article. This research was funded by the University of Wisconsin Consortium for Research and Extension in Agriculture and Natural Resources.

Motto: Discovering and disseminating knowledge about natural resources.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1989—657-602/37